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ABSTRACT

The materials in this packet are designed to aid teachers in the implementation of a science field studies unit concerning tidal rivers. The packet consists of the following: (1) background material for the teacher; (2) lab exercises; (3) field activities; and (4) classroom activities. The overall purpose of this packet is to provide information for organizing and conducting a marine field study, and interpreting and using data gathered from the study. Concepts such as tidal flow theory, the relation of specific gravity to salinity, proper field procedure, and data correlations are included. The activity is designed for secondary school students. Included are objectives, student activity materials, data sheets, discussion topics, a posttest, and a selected bibliography. (RH)

SALINITY CHANGES IN A TIDAL RIVER

A Learning Experience for
Coastal and Oceanic
Awareness Studies

Produced by

MARINE ENVIRONMENT CURRICULUM STUDY
MARINE ADVISORY SERVICE
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and

POPULATION-ENVIRONMENT CURRICULUM STUDY
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UNIVERSITY OF DELAWARE

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PLAN FOR ENVIRONMENTAL EDUCATION

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Please send evaluations

of learning experiences

to

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Newark, Delaware 19711

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TITLE: SALINITY CHANGES IN A TIDAL RIVER

*CONCEPT: I.A.

I. The earth is a finite natural system.

A. THE PROPERTIES AND INTERACTIONS OF WATER, AIR, AND THE PHYSICAL EARTH SET THE LIMITS OF THE NATURAL SYSTEM.

**MARINE CONCEPT: 1.22

1. An abundance of water makes the earth unique in our solar system.

1.2 Water in the environment contains a variety of substances in suspension and in solution.

1.22 DISSOLVED AND SUSPENDED SUBSTANCES AFFECT THE PROPERTIES OF WATER.

SUBJECT: Earth Science

GRADE LEVEL: 10-12

PERIODS: Various

AUTHOR: Caccamise

* From A Conceptual Scheme for Population-Environment Studies, 1973. Cost $2.50

** From Marine Environment Proposed Conceptual Scheme, 1973. No charge.

Both conceptual schemes are available from Robert W. Stegner, Population-Environment Curriculum Study, 310 Willard Hall, University of Delaware, Newark, DE 19711.

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I. INTRODUCTION

The materials in this packet are designed to aid teachers in the implementation of a science field studies unit concerning tidal rivers. The packet consists of 1) background material for the teacher, 2) lab exercises, 3) field activities, and 4) classroom activities. The overall purpose of this packet is to provide prerequisite information for the setting up and carrying out of a marine field study, and to then interpret and use the data gathered from the study. Concepts such as tidal flow theory, the relation of specific gravity to salinity, proper field procedure and data correlations are included to provide a broad base for the study itself. Parts III and IV are included as background information for the actual study in part V .

II. OBJECTIVES

Tides

1) The student will be able to correctly define the following: high tide, low tide, flood tide, ebb tide, tidal range, spring tide, neap tide, diurnal tide period, and semi-diurnal tide period.
2) The student will be able to name correctly at least two tidal forces.
3) The student will be able to correctly read a tide table and graph tides for a 24-hour period.

Hydrometer

1) Given a hydrometer and five water samples, the student will be able to calculate the correct salinity for at least four of the samples.
2) The student will be able to list in proper order steps in using a hydrometer to measure the salinity of a water sample.

Sample Collection and Data Analysis

1) The student will be able to collect a sample, measure its salinity, and record the data correctly.
2) The student will be able to graph salinity content of an area as a function of time and as a function of distance from the mouth of a tidal river.
3) The student will be able to measure and record water temperature using a centigrade thermometer.
4) Using data obtained, the student will be able to chart salinity content and temperature of five points along a tidal river over a five-day period.

III. TIDES

A. Introduction

Though this exercise is directed at advanced high school students, it should not be assumed that these students are well-versed in tidal flow theory. Therefore it is advisable that causes, forces, and effects be reviewed and discussed in advance of the actual field sampling.

B. Important Concepts

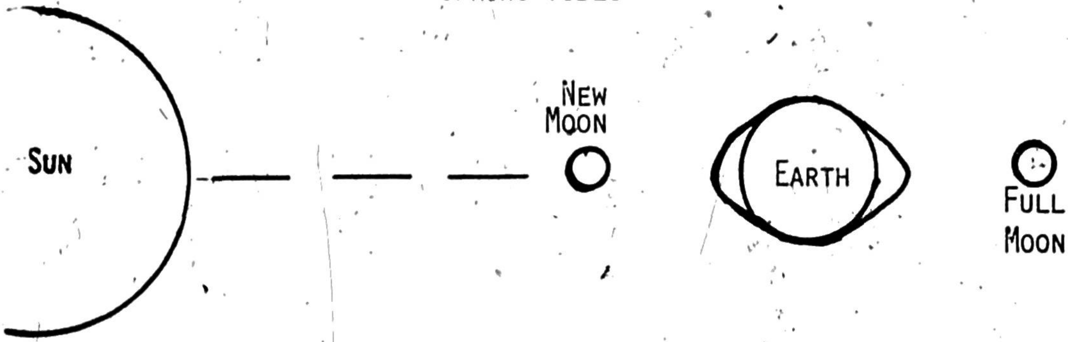
1) Tides are universal, they occur to some degree in all bodies of water (even in your cells).
2) Tides follow a lunar day - high tides occur approximately every 12 hours and 25 minutes - low tides occur every 12 hours and 25 minutes - these are called tidal periods. A total lunar day equals 24 hours and 50 minutes.
3) When the crest of the tidal wave approaches, causing a rise in water level, we have flood tide occurring. The apex is called high tide or high water.
4) When the tide begins to recede, the water level goes down. This is known as ebb tide, and the lowest water level is called low tide or low water.
5) Tides are caused by a bulge of water being "pulled" towards the moon as the earth spins on its axis. A combination of lunar pull and the earth's rotational centrifugal force cause this high water bulging at two opposing axes. At the two right angle axes are two low water areas caused by water displacement toward the "bulges". As the earth rotates through these "bulges" all points on the earth pass through high and low water areas. Since there are two "bulges" and two "depressions", each point meets high water twice and low water twice within a 24 hour and 50 minute lunar day.

6) Position of the moon and sun at different times of the month present special tidal effects. These special tides coincide with what are commonly referred to as the moon's "phases" and show the sun's force in tidal action. Spring tides occur at full moon phase and new moon phase. At full moon, the moon and sun are on opposite sides of the earth in a straight line, causing the pull of the moon on the earth's water to increase at high tide; since more water is pulled into "bulges" there is less water in the "depressions." Thus high tides are higher and low tides are lower. At new moon phase, the sun, moon, and earth are again similarly aligned, again causing a very high water and a very low water. Neap tides occur between the spring tides. At the first and last quarter phases of the moon, the sun is aligned at a 90° angle with the moon and earth: thus, instead of pulling in line <u>with</u> the moon, the sun is actually pulling at right angles to the moon, diminishing to some degree the high and low tides and causing the high water to be lower and the low water to be higher. See Figure 1.

7) At different times of the month and year, the sun and moon are closer to the earth, and the closer they are, the greater the tidal effects. The sun is closer to the equator in spring and fall and the two daily tides then are more or less equal. In January the sun is closer to the Tropic of Capricorn and in July, to the Tropic of Cancer, and unequal tides result because the tidal "bulges" are north and south of the equator on opposite sides of the earth. See Figure 2.

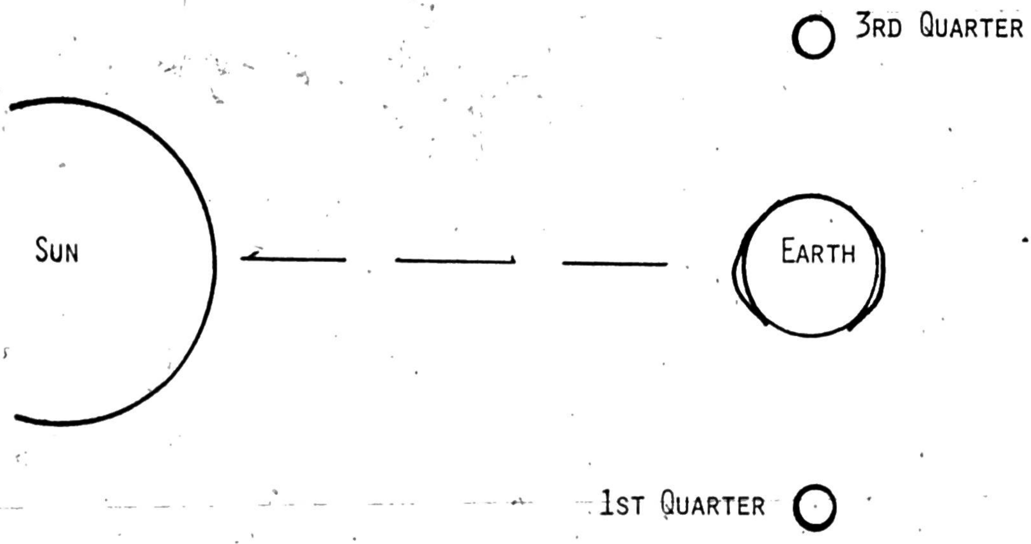
Figure 1

SPRING TIDES



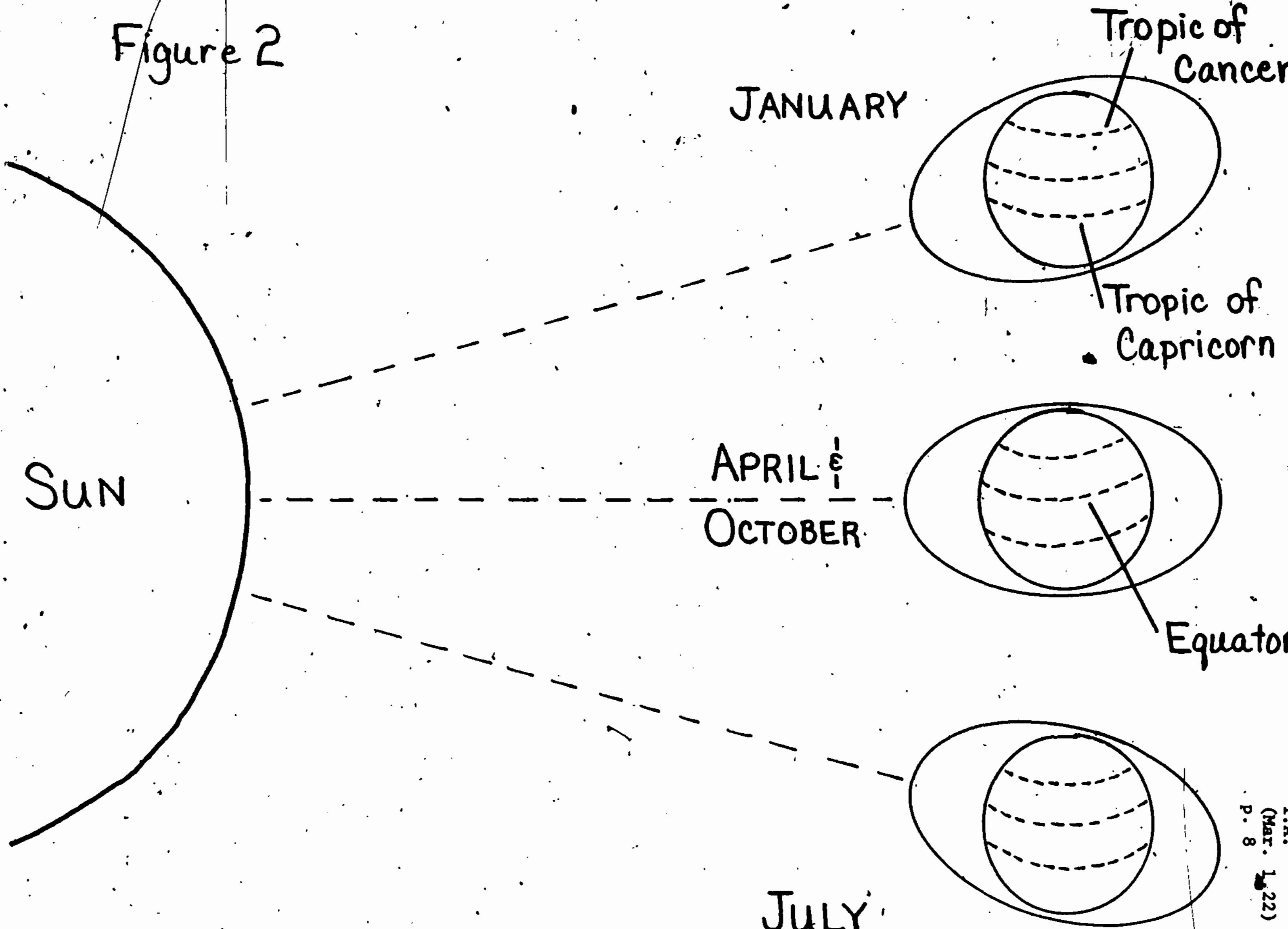
HIGH HIGH TIDES; LOW LOW TIDES

NEAP TIDES



HIGH LOW TIDES; LOW HIGH TIDES

Figure 2



I.A. (Mar. 1, 22) p. 8

8) In tidal rivers, the tide wave will be affected by at least two additional factors, 1) greater friction in a confined area (two sides, shallower bottom) and 2) the opposing oceanward flow of the fresh water river. Both of these factors work against tidal flow causing a shorter flood tide period and a longer ebb tide period. The variance will depend a great deal on the width, length and flow rate of the river. These variables, along with wind, rain, and other weather conditions at the sampling times will affect tidal height. Thus, in a river, the flood periods may be as short as three to four hours and ebb periods as long as eight to nine hours.

C. Tidal Facts

<u>Tidal Periods</u> (along most of the East Coast)

1) From high to high - 12 hrs. 25 min. - semidiurnal
2) From low to low - 12 hrs. 25 min. - semidiurnal
3) From high to low - 6 hrs. 12 1/2 min. - flood
4) From low to high - 6 hrs. 12 1/2 min. - flood
5) Lunar diurnal period - 24 hrs. 50 min.

<u>Tidal Forces</u>

1) Lunar (gravitational)
2) Rotational Centrifugal (earth)
3) Solar (gravitational)

<u>Tidal Variants</u>

1) Wind
2) Friction
3) Size and shape of tidal basin
4) Fresh water flow

VOCABULARY LIST - TIDES

1) High tide - Also high water - time at which water level has risen to its highest point - occurs approximately every 12 hours and 25 minutes.

2) Low tide - Also low water - time at which water level has dropped to its lowest point - occurs approximately every 12 hours and 25 minutes.

3) Flood tide - Period of time during which tidal wave crest approaches area (ends at high water) - water level rising.

4) Ebb tide - Period of time during which high water recedes (ends at low water point) - water level falling.

5) Spring tides - When the sun, moon and earth align with each other causing a greater tidal pull on the earth's surface. Adding the pull of the moon to the pull of the sun results in higher high tides and lower low tides (a maximum tidal range) - occurs twice per month corresponding to new and full moon phases.

6) Neap tides - The sun and moon at right angles to the earth cause opposition of lunar and solar pull - This results in lower high tides and higher low tides (minimum tidal range) - occurs twice per month corresponding to first and last quarter lunar phases.

7) Tidal range - The difference, in feet, between high and low water.

8) Diurnal Tidal Period - Period equivalent to one lunar day or 24 hours and 50 minutes - tides based on this period.

9) Semidiurnal Tidal Period - One half a lunar day - period from high to high or from low to low tide (12 hours and 25 minutes).

D. Reading Tidal Tables

By consulting Tide Tables, predictions published each year by the National Oceanic and Atmospheric Association, tidal conditions in this area can be found.

The times and heights in feet of high and low water for every day of the year are listed for reference stations along the coast. For the calculation of the tides at Slaughter Beach, Bowers Beach, or Indian River Inlet correction factors for both the time and height of the tides must be applied. Furthermore, all tides are given in Standard Time; one hour must be added for Daylight Savings Time (between the last Sunday in April and the last Sunday in October).

EXAMPLE

Goal: Mispillion River Inlet on Thursday 11 May 1972

Procedure:

1) Look up Mispillion River Inlet in the index. This tells you that tides there are based on Breakwater Harbor tides.

2) Look up Breakwater Harbor tides:

11	0021	-0.5
Th	0628	4.1
	1223	-0.6
	1854	5.4

On the left-hand side, $\frac{11}{\text{Th}}$ indicates May 11, a Thursday. The central column gives the times (in military format) of the high and low tides at Breakwater Harbor. The right-hand column indicates in feet the height of the water with respect to mean low water (the average low tide level).

I.A.
(Mar. 1,22)
p. 12

No.	PLACE	POSITION		DIFFERENCES				RANGES		Mean Tide Level
		Lat.	Long.	Time		Height		Mean	Spring	
				High water	Low water	High water	Low water			
		° ′	° ′	h. m.	h. m.	feet	feet	feet	feet	feet
	NEW JERSEY, Outer Coast—Continued	N.	W.	on SANDY HOOK, p.70 *Time meridian, 75°W.*						
	Great Egg Harbor River									
1719	Scull Landing	39 22	74 43	+1 43	+1 54	−0.9	0.0	3.7	4.5	1.8
1721	Mays Landing	39 27	74 44	+2 34	+2 39	−0.6	0.0	4.0	4.8	2.0
1723	Peck Bay (34th Street bridge)	39 15	74 38	+0 51	+1 02	−0.9	0.0	3.7	4.5	1.8
1725	Devils Island, Crook Horn Creek	39 14	74 39	+0 37	+0 22	−1.0	0.0	3.6	4.4	1.8
1727	Corson Inlet (bridges)	39 13	74 39	+0 09	+0 04	−0.7	0.0	3.9	4.7	1.9
1729	Ben Hands Thorofare	39 12	74 40	+0 48	+0 32	−0.9	0.0	3.7	4.5	1.8
1731	Sea Isle City (Ludlam Thoro. bridge)	39 09	74 42	+0 45	+0 49	−0.8	0.0	3.8	4.6	1.9
1733	Sea Isle City (beach)	39 09	74 41	−0 19	−0 19	−0.5	0.0	4.1	5.0	2.0
1735	Townsend Inlet	39 07	74 43	+0 06	+0 04	−0.8	0.0	3.8	4.6	1.9
1737	Long Reach	39 06	74 45	+0 53	+0 53	−0.8	0.0	3.8	4.6	1.9
1739	Great Sound (ent. to Cresse Thoro.)	39 05	74 47	+1 03	+1 05	−0.5	0.0	4.1	5.0	2.0
1741	Stone Harbor (Great Chan. bridge)	39 03	74 46	+0 42	+0 26	−0.5	0.0	4.1	5.0	2.0
1743	Hereford Inlet (North Wildwood)	39 01	74 48	+0 02	+0 02	−0.5	0.0	4.1	5.0	2.0
1745	Wildwood (beach)	38 59	74 48	−0 15	−0 19	−0.5	0.0	4.1	5.0	2.0
1747	Grassy Sound Channel (hwy. bridge)	39 02	74 49	+0 40	+0 28	−0.5	0.0	4.1	5.0	2.0
1749	W. Wildwood (Grassy Sound bridge)	39 00	74 50	+0 45	+0 29	−0.3	0.0	4.3	5.2	2.1
1751	Swain Channel	38 59	74 52	+0 54	+0 27	−0.2	0.0	4.4	5.3	2.2
1753	Cape May Harbor	38 57	74 53	−0 02	−0 16	−0.2	0.0	4.4	5.3	2.2
1755	Cape May, Municipal Pier	38 56	74 55	+0 02	−0 17	−0.3	0.0	4.3	5.2	2.1
	NEW JERSEY and DELAWARE **Delaware Bay, Eastern Shore**			on BREAKWATER HBR., p.74						
1757	Five Fathom Bank	38 51	74 38	−0 43	−0 38	0.0	0.0	4.1	4.9	2.0
1759	McCrie Shoal	38 51	74 51	−0 22	−0 21	+0.2	0.0	4.3	5.2	2.1
1761	Cape May Point	38 56	74 58	−0 10	−0 04	+0.6	0.0	4.7	5.6	2.3
1763	Bay Shore Channel	38 58	74 58	−0 09	−0 03	+0.8	0.0	4.9	5.8	2.4
1765	Miami Beach	39 02	74 56	+0 17	+0 26	+1.0	0.0	5.1	6.1	2.5
1767	Dennis Creek entrance	39 10	74 54	+0 48	+1 04	+1.5	0.0	5.6	6.6	2.8
1769	East Point, Maurice River Cove	39 12	75 02	+0 55	+1 12	+1.6	0.0	5.7	6.7	2.8
	Maurice River									
1771	Port Norris	39 14	75 02	+1 14	+1 38	+1.6	0.0	5.7	6.7	2.8
1773	Mauricetown	39 17	75 00	+1 48	+2 21	+1.7	0.0	5.8	6.8	2.9
1775	Millville	39 24	75 02	+2 37	+3 23	+1.9	0.0	6.0	7.0	3.0
1777	Egg Island Point	39 11	75 08	+0 33	+1 02	+1.6	0.0	5.7	6.7	2.8
				on REEDY POINT, p.78						
1779	Fortescue	39 14	75 10	−2 05	−2 19	+0.4	0.0	5.9	7.0	2.9
1781	Ben Davis Point	39 17	75 17	−1 40	−1 49	+0.5	0.0	6.0	6.9	3.0
	Cohansey River									
1783	Entrance	39 21	75 22	−1 30	−1 29	+0.5	0.0	6.0	6.9	3.0
1785	Laning Wharf	39 23	75 20	−1 10	−1 14	+0.5	0.0	6.0	6.8	3.0
1787	Fairton	39 23	75 14	+0 05	−0 24	+0.7	0.0	6.2	7.0	3.1
1789	Bridgeton	39 25	75 14	+0 27	−0 13	+1.0	0.0	6.5	7.3	3.2
1791	Bay Side	39 23	75 24	−1 23	−1 22	+0.6	0.0	6.1	6.9	3.0
	Delaware Bay, Central Lighthouses			on BREAKWATER HBR., p.74						
1793	Brandywine Shoal Light	38 59	75 07	+0 09	+0 28	+0.8	0.0	4.9	5.9	2.4
1795	Fourteen Foot Bank Light	39 03	75 11	+0 18	+0 48	+1.1	0.0	5.2	6.2	2.6
1797	Miah Maull Shoal Light	39 08	75 13	+0 28	+1 08	+1.4	0.0	5.5	6.5	2.7
1799	Elbow of Cross Ledge Light	39 11	75 16	+0 40	+1 21	+1.5	0.0	5.6	6.5	2.8
				on REEDY POINT, p.78						
1801	Ship John Shoal Light	39 18	75 23	−1 32	−1 36	+0.2	0.0	5.7	6.6	2.8
	Delaware Bay, Western Shore			on BREAKWATER HBR., p.74						
1803	Cape Henlopen	38 48	75 05	−0 05	−0 05	0.0	0.0	4.1	4.9	2.0
1805	BREAKWATER HARBOR	38 47	75 06	Daily predictions				4.1	4.9	2.1
1807	Roosevelt Inlet	38 49	75 12	+0 09	+0 13	+0.3	0.0	4.4	5.2	2.2
1809	Mispillion River entrance	38 57	75 19	+0 33	+1 00	+0.5	0.0	4.6	5.4	2.3
1811	Murderkill River entrance	39 04	75 24	+0 56	+1 32	+0.7	0.0	4.8	5.7	2.4

BREAKWATER HARBOR, DEL., 1972

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

APRIL

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0352	-0.2	16	0408	-0.8
SA	0959	3.6	SU	1014	4.0
	1549	0.1		1606	-0.6
	2212	4.3		2237	5.3
2	0431	0.0	17	0501	-0.6
SU	1036	3.4	M	1109	3.8
	1623	0.2		1659	-0.3
	2247	4.2		2335	5.0
3	0512	0.1	18	0601	-0.3
M	1113	3.2	TU	1211	3.5
	1700	0.3		1757	0.0
	2329	4.1			
4	0554	0.3	19	0036	4.7
TU	1157	3.0	W	0705	0.0
	1745	0.5		1318	3.4
				1902	0.2
5	0020	4.0	20	0144	4.4
W	0649	0.5	TH	0813	0.2
	1249	2.9		1427	3.3
	1836	0.6		2014	0.4
6	0113	3.9	21	0253	4.1
TH	0746	0.6	F	0918	0.3
	1347	2.9		1535	3.4
	1936	0.6		2127	0.5
7	0210	3.8	22	0400	4.0
F	0845	0.5	SA	1017	0.3
	1454	3.0		1638	3.6
	2045	0.5		2233	0.4
8	0322	3.9	23	0458	3.9
SA	0941	0.4	SU	1108	0.3
	1557	3.2		1727	3.9
	2146	0.3		2330	0.3
9	0420	4.0	24	0547	3.9
SU	1037	0.2	M	1151	0.2
	1653	3.7		1812	4.1
	2249	0.0			
10	0516	4.2	25	0019	0.2
M	1127	-0.1	TU	0632	3.8
	1742	4.1		1227	0.2
	2347	-0.3		1851	4.3
11	0605	4.4	26	0100	0.1
TU	1212	-0.4	W	0713	3.6
	1833	4.6		1300	0.1
				1927	4.5
12	0041	-0.6	27	0139	0.0
W	0657	4.5	TH	0748	3.7
	1257	-0.7		1333	0.1
	1919	5.1		2000	4.6
13	0135	-0.8	28	0218	-0.1
TH	0745	4.5	F	0823	3.6
	1342	-0.8		1407	0.1
	2007	5.4		2035	4.6
14	0226	-1.0	29	0253	-0.1
F	0834	4.4	SA	0859	3.5
	1428	-0.9		1442	0.1
	2056	5.5		2110	4.6
15	0319	-0.9	30	0331	0.0
SA	0923	4.2	SU	0934	3.4
	1515	-0.8		1517	0.2
	2148	5.5		2146	4.5

MAY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0400	0.1	16	0450	-0.5
M	1011	3.3	TU	1056	3.7
	1552	0.3		1643	-0.2
	2225	4.5		2319	5.1
2	0449	0.2	17	0549	-0.2
TU	1050	3.2	W	1157	3.6
	1635	0.4		1741	0.1
	2306	4.3			
3	0533	0.3	18	0020	4.7
W	1130	3.1	TH	0644	0.0
	1716	0.5		1258	3.5
	2349	4.2		1844	0.3
4	0624	0.4	19	0119	4.4
TH	1225	3.1	F	0744	0.2
	1811	0.6		1407	3.6
				1953	0.5
5	0042	4.1	20	0222	4.1
F	0715	0.4	SA	0839	0.3
	1321	3.1		1508	3.7
	1909	0.6		2101	0.6
6	0140	4.0	21	0322	3.8
SA	0809	0.4	SU	0932	0.3
	1422	3.3		1603	3.8
	2016	0.5		2204	0.6
7	0243	4.0	22	0417	3.7
SU	0902	0.2	M	1020	0.3
	1523	3.7		1653	4.0
	2119	0.4		2301	0.5
8	0339	4.0	23	0510	3.3
M	0953	0.0	TU	1102	0.3
	1619	4.1		1736	4.2
	2223	0.1		2349	0.4
9	0439	4.0	24	0557	3.5
TU	1044	-0.2	W	1143	0.3
	1713	4.6		1817	4.4
	2320	-0.2			
10	0536	4.1	25	0034	0.3
W	1134	-0.4	TH	0638	3.4
	1806	5.0		1219	0.3
				1854	4.5
11	0021	-0.5	26	0113	0.2
TH	0628	4.1	F	0720	3.4
	1223	-0.6		1257	0.2
	1854	5.4		1933	4.6
12	0117	-0.7	27	0154	0.1
F	0720	4.2	SA	0755	3.4
	1312	-0.7		1336	0.2
	1945	5.6		2010	4.7
13	0209	-0.8	28	0231	0.1
SA	0813	4.1	SU	0833	3.4
	1401	-0.7		1411	0.2
	2037	5.7		2047	4.7
14	0302	-0.8	29	0311	0.1
SU	0906	4.0	M	0912	3.3
	1452	-0.6		1450	0.2
	2129	5.6		2123	4.7
15	0355	-0.7	30	0349	0.1
M	1000	3.9	TU	0951	3.3
	1547	-0.4		1529	0.2
	2225	5.4		2204	4.6
			31	0429	0.1
			W	1032	3.3
				1615	0.3
				2244	4.5

JUNE

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0512	0.1	16	0616	-0.1
TH	1113	3.3	F	1233	3.8
	1658	0.4		1821	0.3
	2328	4.4			
2	0554	0.2	17	0047	4.3
F	1202	3.4	SA	0709	0.1
	1751	0.4		1328	3.8
				1922	0.5
3	0016	4.3	18	0142	3.9
SA	0643	0.1	SU	0753	0.3
	1255	3.5		1425	3.8
	1846	0.5		2023	0.7
4	0107	4.1	19	0237	3.6
SU	0732	0.1	M	0842	0.4
	1351	3.8		1519	3.9
	1951	0.4		2125	0.7
5	0204	4.0	20	0334	3.4
M	0827	0.0	TU	0927	0.4
	1451	4.1		1609	4.0
	2055	0.4		2223	0.7
6	0306	3.9	21	0425	3.2
TU	0914	-0.1	W	1013	0.5
	1548	4.5		1657	4.2
	2200	0.2		2319	0.6
7	0407	3.8	22	0515	3.2
W	1006	-0.3	TH	1057	0.5
	1646	4.8		1740	4.3
	2305	0.0			
8	0505	3.8	23	0003	0.5
TH	1101	-0.4	F	0606	3.2
	1740	5.2		1140	0.4
				1825	4.5
9	0006	-0.3	24	0048	0.4
F	0606	3.8	SA	0647	3.2
	1158	-0.5		1222	0.3
	1836	5.4		1904	4.6
10	0107	-0.4	25	0130	0.3
SA	0701	3.8	SU	0730	3.3
	1249	-0.6		1306	0.2
	1931	5.6		1946	4.7
11	0157	-0.5	26	0211	0.2
SU	0757	3.9	M	0811	3.3
	1344	-0.6		1346	0.2
	2024	5.6		2026	4.8
12	0251	-0.6	27	0250	0.1
M	0853	3.9	TU	0849	3.4
	1438	-0.5		1430	0.1
	2116	5.5		2104	4.8
13	0343	-0.5	28	0329	0.0
TU	0947	3.9	W	0930	3.5
	1533	-0.4		1511	0.1
	2209	5.3		2142	4.8
14	0434	-0.4	29	0409	0.0
W	1042	3.8	TH	1010	3.6
	1627	-0.2		1556	0.1
	2300	5.0		2223	4.7
15	0525	-0.2	30	0447	-0.1
TH	1136	3.8	F	1053	3.7
	1722	0.1		1643	0.1
	2354	4.7		2304	4.6

TIME MERIDIAN 75° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOW WATER.

Thus, at 0021 (21 minutes past midnight, local standard time), the tide will be .5 ft. below the average low tide level. This is obviously a low tide. At 0628 early in the morning the tide will be 4.1 ft. above the average low tide level. This is a high tide. Looking further at this table we see that the low tide near noon will be lower than the low tide at midnight was. The high tide in the evening will be higher than the early morning high tide was.

3) Since 11 May is during Daylight Savings Time, add one hour to the predictions:

11	0121	-0.5
Th	0728	4.1
	1323	-0.6
	1954	5.4

Then, for convenience, convert from military time to conventional time. Use the clock on the next page.

11	1:21 A.M.	-0.5
Th	7:28 A.M.	4.1
	1:23 P.M.	-0.6
	7:54 P.M.	5.4

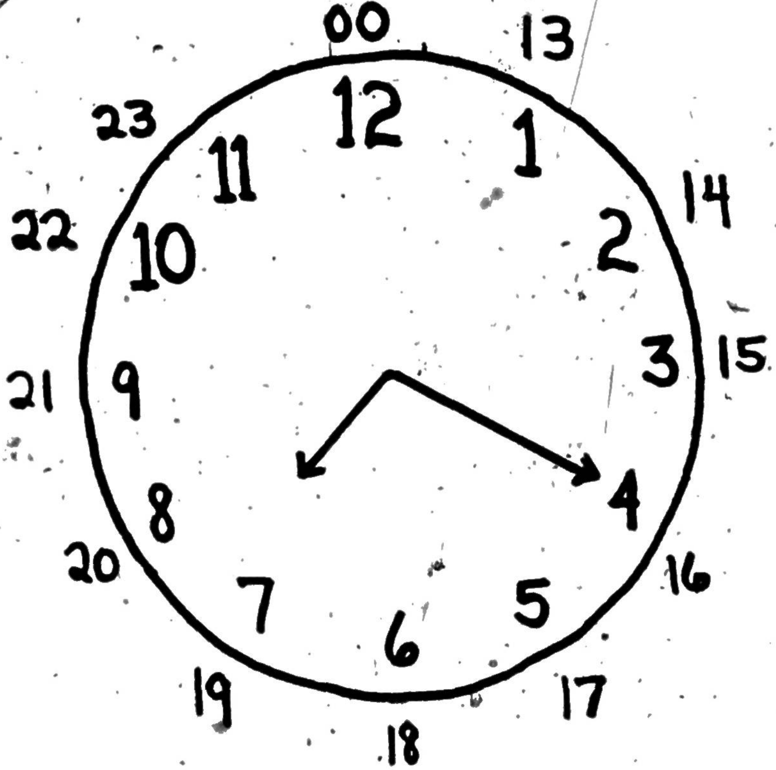
4) Apply the correction factors for time and height to obtain tidal information for Mispillion River Inlet.

Differences

Time				Height	
High Water		Low Water		High Water	Low Water
h	m	h	m	ft.	ft.
+0	33	+1	00	+0.5	0.0

Thus, to the high water times given for Breakwater Harbor add 33 minutes, and, to the low water times add 1 hour. To determine the high water heights add .5 ft., do not change the low water levels.

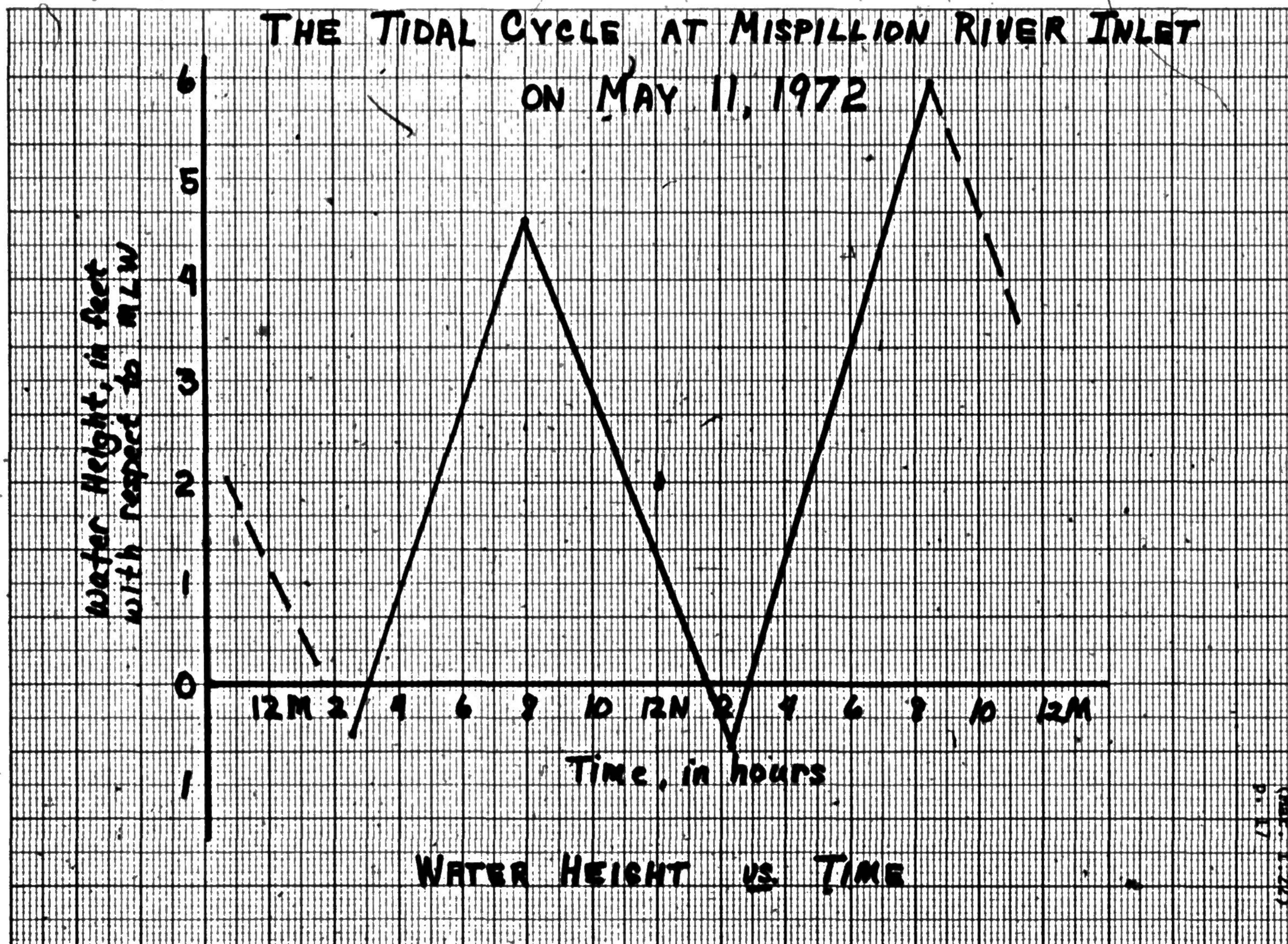
A CLOCK FOR CONVERTING MILITARY TIME TO CONVENTIONAL TIME



MILITARY TIME	CONVENTIONAL TIME
0720	7:20 a.m.
1920	7:20 p.m.

11	2:21 A.M.	-0.5
Th	8:01 A.M.	4.6
	2:23 P.M.	-0.6
	8:27 P.M.	5.9

5) This means that low tides will occur at Mispillion Inlet at 2:11 A.M. and at 2:23 P.M. while high tides will occur at 8:01 A.M. and 8:27 P.M. The low tides will be .5 ft. and 0.6 ft. below mean low water, respectively. The high tides will be 4.6 ft. and 5.9 ft. above mean low water.


THE TIDAL CYCLE AT MISPILLION RIVER INLET
ON MAY 11, 1972
Water Height, in feet
with respect to MLW
6
5
4
3
2
1
0
1
12M 2 4 6 8 10 12N 2 4 6 8 10 12M
Time, in hours
WATER HEIGHT vs. TIME

IV. SALINITY MEASUREMENT WITH A STEM HYDROMETER

A. Specific Gravity and Salinity

Density of a liquid $\frac{(\text{mass})}{(\text{volume})}$ increases as salinity content increases, if all other factors including temperature remain constant. Specific Gravity is the ratio of the density of a specific solution or liquid to the density of pure water at 4°C. At this temperature, pure water has a specific gravity of 1.0000. Those solutions less dense than pure water have a specific gravity =0.9999 or less, while those denser than pure water will have a specific gravity =1.0001 or greater.

Tables relating specific gravities and salinities of a liquid have been devised using a convenient ideal temperature. Also temperature correction factors can be used to adjust salinities determined at other temperatures. Both of these tables will be used in our study to help measure salinity in river water samples.

B. The Stem Hydrometer

The stem hydrometer, possibly devised by Archimedes, is an instrument used to measure specific gravity. A picture of this instrument is shown in figure 3A. A hydrometer may be used to measure salinity content by carefully following this step-by-step procedure:

1. Take the current temperature of the sample to be tested in Centigrade.
2. Over a sink, fill the hydrometer test jar or graduated cylinder with approximately 275 ml of the water sample.
3. Gently lower the hydrometer into the sample and allow it to settle.
4. Place the jar on a level surface and read the hydrometer. Notice how the solution tends to "climb" the sides of the hydrometer stem (See figure 3B). This curved upper surface of the sample around the hydrometer is called a meniscus. When reading the hydrometer, this meniscus should be ignored and an imaginary straight line should be drawn across the solution level. This is the reading which should be recorded. See figure 4 to learn how to read a hydrometer accurately.
5. Using the specific gravity measurement taken, refer to Table 1 and find the corresponding salinity content of the sample. Record this salinity in parts per thousand ($^{0}/00$) as the observed salinity.
6. From Table 2, using the observed salinity value and the temperature of the sample, find the temperature corrected salinity.

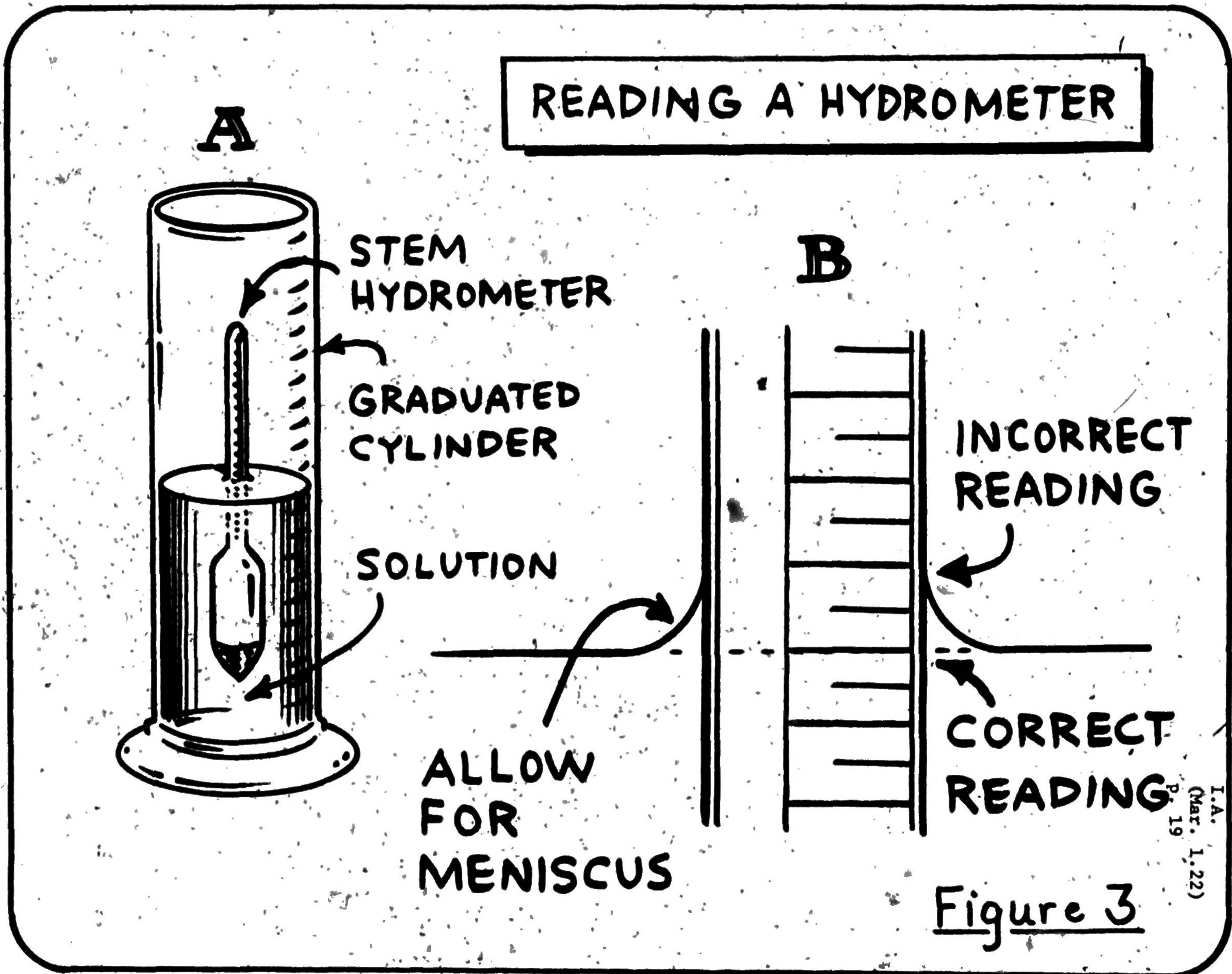

READING A HYDROMETER
A
STEM HYDROMETER
GRADUATED CYLINDER
SOLUTION
B
INCORRECT READING
CORRECT READING
ALLOW FOR MENISCUS
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Figure 3

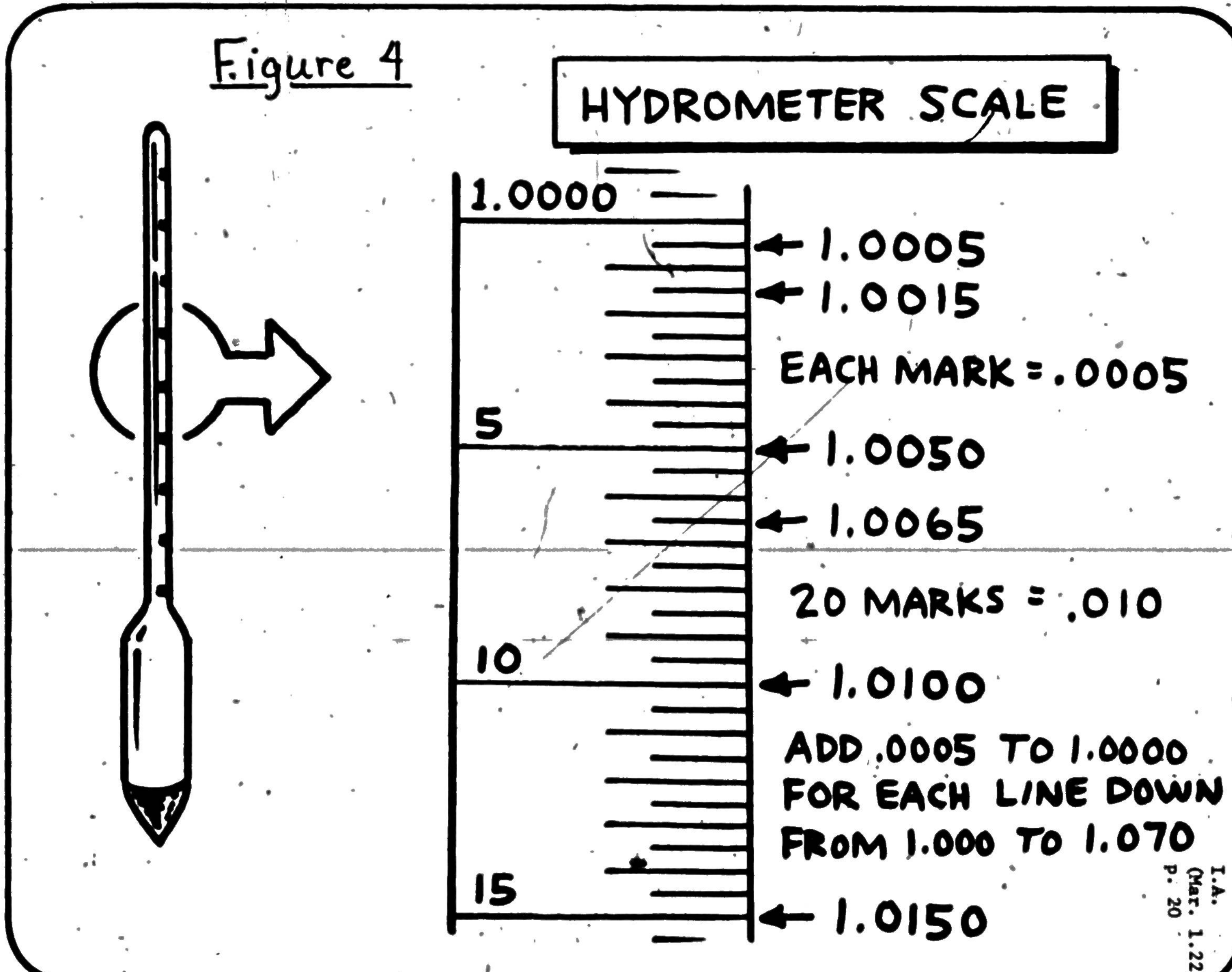

Figure 4

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TABLE 1

Corresponding Densities and Salinities
(density at 15°C; salinity in 0/00)

Density	Salinity	Density	Salinity
1.0000	1.0	1.0155	21.5
1.0005	1.5	1.0160	22.0
1.0010	2.5	1.0165	22.5
1.0015	3.0	1.0170	23.5
1.0020	3.5	1.0175	24.0
1.0025	4.5	1.0180	24.5
1.0030	5.0	1.0185	25.0
1.0035	5.5	1.0195	26.5
1.0040	6.5	1.0200	27.0
1.0045	7.0	1.0205	28.0
1.0050	7.5	1.0210	28.5
1.0055	8.0	1.0215	29.0
1.0060	9.0	1.0220	30.0
1.0065	9.5	1.0225	30.5
1.0070	10.0	1.0230	31.0
1.0075	11.0	1.0235	32.0
1.0080	11.5	1.0240	32.5
1.0085	12.0	1.0245	33.0
1.0090	13.0	1.0250	33.5
1.0095	13.5	1.0255	34.5
1.0100	14.0	1.0260	35.0
1.0105	15.0	1.0265	36.0
1.0110	15.5	1.0270	36.5
1.0015	16.0	1.0275	37.0
1.0120	16.5	1.0280	37.5
1.0125	17.5	1.0285	38.0
1.0130	18.0	1.0290	39.0
1.0035	18.5	1.0295	39.5
1.0140	19.5	1.0300	40.0
1.0145	20.0	1.0305	41.0
1.0150	20.5	1.0310	41.5

TABLE 2

True Salinities for Sea Water – Corrected to 15°C

Temp. of Water in Jar	CORRECTED OR TRUE SALINITIES																			
	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
	OBSERVED SALINITIES																			
-2°C	1.7	2.8	3.9	5.0	6.1	7.2	8.2	9.2	10.3	11.3	12.4	13.4	14.4	15.5	16.5	17.6	18.6	19.7	20.8	21.9
0	1.8	2.9	4.0	5.1	6.2	7.3	8.3	9.4	10.4	11.5	12.6	13.6	14.6	15.7	16.7	11.7	18.8	19.9	21.0	22.1
2	1.8	2.9	4.0	5.1	6.2	7.3	8.4	9.4	10.5	11.5	12.6	13.6	14.6	15.7	16.7	17.8	18.8	19.9	20.9	22.0
4	1.8	2.9	4.0	5.1	6.2	7.3	8.4	9.4	10.5	11.5	12.6	13.6	14.6	15.7	16.7	17.7	18.8	19.9	20.8	21.8
6	1.7	2.8	3.9	5.1	6.2	7.3	8.4	9.4	10.4	11.4	12.4	13.5	14.5	15.5	16.5	17.5	18.6	19.6	20.6	21.7
8	1.7	2.8	3.9	5.0	6.1	7.1	8.2	9.2	10.2	11.2	12.2	13.3	14.3	15.3	16.3	17.3	18.3	19.4	20.4	21.4
10	1.6	2.7	3.7	4.8	5.8	6.8	7.9	8.9	9.9	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0
12	1.4	2.4	3.4	4.5	5.6	6.6	7.6	8.6	9.6	10.6	11.6	12.6	13.6	14.7	15.7	16.7	17.7	18.7	19.7	20.7
14	1.1	2.1	3.1	4.1	5.2	6.2	7.2	8.2	9.2	10.2	11.2	12.2	13.2	14.2	15.2	16.2	17.2	18.2	19.2	20.2
15	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
16	0.8	1.8	2.8	3.8	4.8	5.8	6.8	7.8	8.8	9.8	10.8	11.8	12.8	13.8	14.8	15.8	16.8	17.8	18.7	19.7
18	0.4	1.4	2.3	3.3	4.3	5.3	6.2	7.2	8.2	9.2	10.2	11.2	13.2	14.2	15.2	16.2	17.2	18.2	19.2	20.2
20	—	0.9	1.8	2.8	3.8	4.8	5.7	6.7	7.7	8.7	9.7	10.6	11.6	12.6	13.6	14.6	15.6	16.6	17.6	18.6
22	—	0.4	1.3	2.3	3.3	4.2	5.1	6.1	7.1	8.1	9.1	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0
24	—	—	0.8	1.8	2.7	3.6	4.5	5.5	6.5	7.4	8.4	9.4	10.4	11.3	12.3	13.3	14.3	15.5	16.3	17.3
26	—	—	0.3	1.1	2.1	3.0	3.9	4.8	5.8	6.7	7.7	8.7	9.7	10.6	11.6	12.6	13.5	14.5	15.5	16.5
28	—	—	—	0.3	1.2	2.2	3.1	4.1	5.0	6.0	6.9	7.9	8.9	9.8	10.8	11.8	12.7	13.7	14.7	15.7
30	—	—	—	—	0.3	1.3	2.3	3.3	4.2	5.2	6.1	7.1	8.1	9.0	10.0	11.0	11.9	12.9	13.9	14.9

Temp. of Water in Jar	CORRECTED OR TRUE SALINITIES																			
	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0	37.0	38.0	39.0	40.0
	OBSERVED SALINITIES																			
-2°C	22.9	24.1	25.1	26.2	27.2	28.3	29.4	30.4	31.5	32.5	33.6	34.6	35.7	36.7	37.8	38.9	40.9	41.0	42.0	43.0
0	23.1	24.2	25.2	26.3	27.3	28.3	29.4	30.4	31.5	32.5	33.6	34.6	35.6	36.7	37.7	38.8	39.8	40.9	41.9	42.9
2	23.0	24.0	25.1	26.1	27.2	28.2	29.3	30.3	31.4	32.4	33.4	34.5	35.5	36.6	37.6	38.7	39.7	40.7	41.7	42.7
4	22.9	23.9	25.0	26.0	27.0	28.1	29.1	30.1	31.2	32.2	33.2	34.2	35.3	36.3	37.4	38.4	39.4	40.4	41.4	42.4
6	22.7	23.7	24.7	25.8	26.8	27.8	28.9	29.9	30.9	31.9	33.0	34.0	35.0	36.0	37.1	38.1	39.1	40.1	41.1	42.1
8	22.4	23.5	24.5	25.5	26.5	27.5	28.5	29.6	30.6	31.6	32.6	33.6	34.6	35.7	36.7	37.7	38.7	39.8	40.8	41.8
10	22.1	23.1	24.1	25.1	26.1	27.2	28.2	29.2	30.2	31.2	32.2	33.2	34.3	35.3	36.3	37.3	38.3	39.3	40.3	41.3
12	21.7	22.7	23.7	24.7	25.7	26.7	27.7	28.8	29.8	30.8	31.8	32.8	33.8	34.8	35.8	36.8	37.8	38.8	39.8	40.8
14	21.2	22.2	23.2	24.2	25.2	26.2	27.2	28.2	29.2	30.2	31.2	32.3	33.3	34.3	35.3	36.3	37.3	38.3	39.3	40.3
15	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0	37.0	38.0	39.0	40.0
16	20.7	21.7	22.7	23.7	24.7	25.7	26.7	27.7	28.7	29.7	30.7	31.7	32.7	33.7	34.7	35.7	36.7	37.7	38.7	39.7
18	20.2	21.2	22.2	23.1	24.1	25.1	26.1	27.1	28.1	29.1	30.1	31.1	32.1	33.1	34.1	35.1	36.1	37.1	38.1	39.1
20	19.6	20.6	21.6	22.5	23.5	24.5	25.5	26.5	27.5	28.5	29.4	30.4	31.4	32.4	33.4	35.4	35.4	36.4	37.4	38.4
22	19.0	19.9	20.9	21.9	22.9	23.8	24.8	25.8	26.8	27.8	29.7	30.7	31.7	32.7	33.7	34.7	35.7	36.7	38.7	39.7
24	18.3	19.2	20.2	21.2	22.2	23.1	24.1	25.1	26.1	27.1	28.1	29.0	30.0	31.0	32.0	33.0	34.0	34.9	35.9	36.9
26	17.5	18.5	19.5	20.4	21.4	22.4	23.4	24.4	25.4	26.3	27.3	28.2	29.2	30.2	31.2	32.3	33.1	34.1	35.1	36.1
28	16.7	17.7	18.7	19.6	20.6	21.6	22.6	23.5	24.5	25.5	26.5	27.4	28.4	29.4	30.4	31.4	32.3	33.3	34.3	35.3
30	15.8	16.8	17.8	18.7	19.7	20.7	21.7	22.6	23.6	24.6	25.6	26.5	27.5	28.5	29.5	30.4	31.4	32.4	33.4	34.4

Taken from Rabinowitz, A., et al., 1970, Oceanography: An Environmental Approach to Marine Science, 2nd ed., Oceanography Unlimited, Paterson, N.J., p. 194.

DETERMINING SALINITY FROM SPECIFIC GRAVITY

Here are two samples:

1) Using Table 1 we see that an observed density of 1.0140 (read at 28°C) corresponds to an observed salinity of 19.5. On Table 2 we see that an observed salinity of 19.5 lies between 18.7 and 19.6. Since 19.5 is very close to 19.6, the corrected salinity is very close to 24.0. Interpolating, we find that an observed salinity of 19.5 corresponds to a corrected salinity of 23.9.

2) An observed density of 1.0230 (read at 20°C) corresponds to an observed salinity of 31.0. On Table 2, we see that 31.0 lies between 30.4 and 31.4. Interpolating, we find that our corrected salinity is 32.6.

Now, you try the following examples. Complete the chart using Tables 1 and 2.

Observed Density	Observed Temperature	Observed Salinity	Corrected Salinity
1.0080	18°C		
1.0030	30°C		
1.0300	15°C		
1.0005	10°C		
1.0170	20°C		

Answers to examples on preceding page:

Observed Salinity	Corrected Salinity
11.5	12.3
5.0	9.8
40.0	40.0
1.5	< 1.0
23.5	25.0

Suggestion to teacher

An easy way to prepare for the activity on the following page, Practice on Measuring Salinities, is to dissolve 2/3 lb. salt into 2 gal. distilled water. This solution approximates full-strength sea water. Take 1 gallon of this solution and add a gallon of distilled water, then take half of the latter solution and again dilute 1:1 with distilled water. Continue making serial dilutions until you have 1 gallon each of 5 different solutions which should be approximately 1, 1/2, 1/4, 1/8, and 1/16 times as salty as sea water.

2 gal. H_2O + 2/3 lb. salt → 1 gal. (full strength)

↓

1 gal. + 1 gal. H_2O

2 gal. → 1 gal. (1/2 strength)

↓

1 gal. + 1 gal. H_2O

2 gal. → 1 gal. (1/4 strength)

↓

1 gal. + 1 gal. H_2O

2 gal. → 1 gal. (1/8 strength)

↓

1 gal. + 1 gal. H_2O → 2 gal. (1/16 strength)

E. Practice on Measuring Salinities

Your teacher has provided you with several salt water samples.

Measure the specific gravity and temperature of each, and, using Tables 1 and 2, calculate the salinity of each sample.

Fill in the chart below.

	Sample #1	Sample #2	Sample #3	Sample #4	Sample #5
Specific Gravity					
Temperature					
Observed Salinity					
Temperature Corrected Salinity					

V. SAMPLING STUDY

A. Materials List

(Needed for Field Study)

<u>Materials</u> needed by each group.

1 gallon plastic jar with wide mouth and cover, (found in school cafeterias, restaurants, etc.)

20 foot length clothesline rope

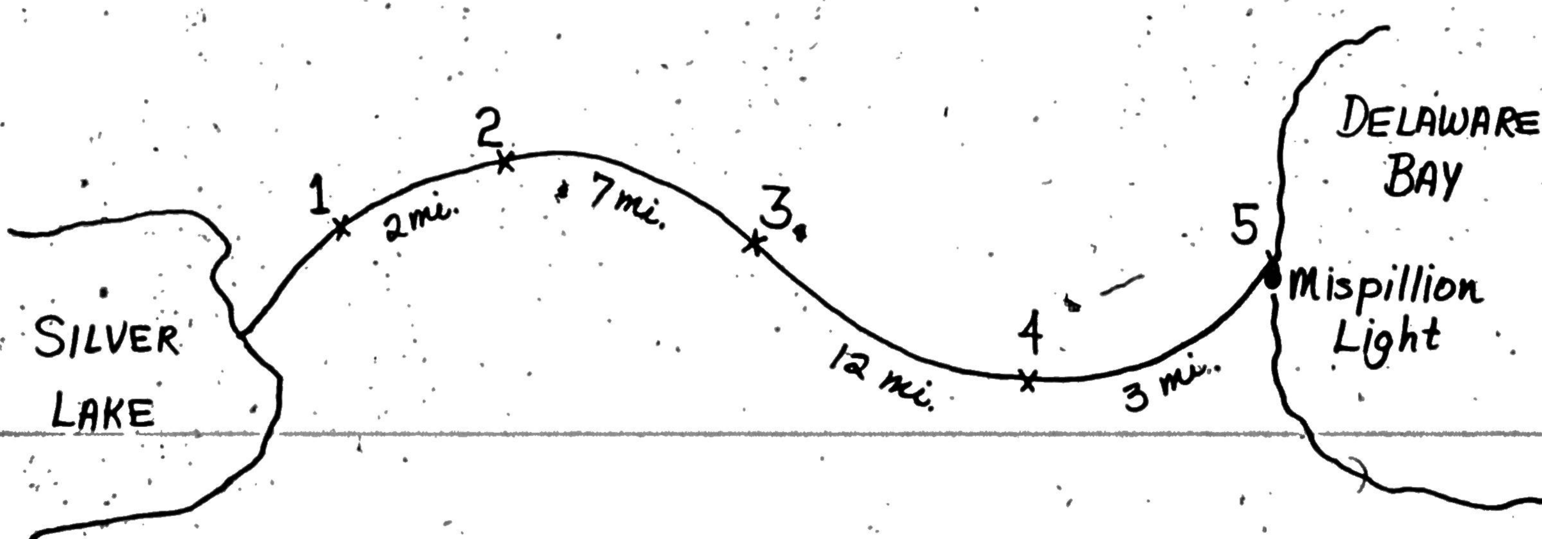
Centigrade thermometer

Hydrometer

Hydrometer jar or 300 ml graduate cylinder

Figure 5

B. SAMPLE AREA MAP
MISPILLION RIVER STATIONS



1 Walnut Street Area

2 Route 14 Bridge Area

3 Farm Area

4 Marsh Area

5 Mispillion Light Area

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C. Water Sample Procedure

This field study is designed to illustrate tidal movement along a river by measuring the salinity concentrations at different river stations at different times within tidal periods. Nearly any river or stream may be used for this study provided that it emanates from a fresh water source and empties into a salt water body. Though large rivers may be used for this study, smaller, more accessible rivers or creeks are much easier to work with.

Throughout this study, students will be measuring and recording <u>two</u> tidal river variables: 1) salinity concentrations and 2) temperatures.

<u>Procedure</u>

1) <u>General Information</u> This study is designed for a normal working class of 25 - 30 students, who will be divided into 5 groups of 5 - 6 people. At least 1 adult (parent) chaperone or supervisor will also be required to oversee operations of each group at their test station. If possible, these chaperones may also be used as chauffeurs to and from the sampling areas each day. Otherwise, the teacher should provide for buses to be used each day throughout the sample period.

2) <u>Sampling Period</u> The length of time required to conduct this study is approximately one hour per day in the field for five days. In addition, another 30 - 45 minutes will also be needed in the laboratory each day for salinity hydrometer analysis and data recording. At the conclusion of the actual lab and field tests, an additional flexible amount of time (perhaps 2 or 3 class periods) should be set aside for discussion of the data accumulated. (See Discussion Topics)

3) <u>Sampling Area</u> Once the tidal river has been selected, five water sample collection areas should be chosen along its banks. Considerations used to choose these areas should be the following: 1) <u>Accessibility</u>. Is it easy to get to? 2) <u>Convenience</u>. Is there working room? 3) <u>Representability</u>. Does this area help give a good test cross section of the river for our study? One of the areas selected should be as near the salt water opening of the river as possible. Another should be as near to the furthest point

of salt water intrusion into the river as is possible. The remaining 3 areas should be spaced fairly evenly between these two points at convenient collection localities. River bridges or overpasses located along the river may be used for sample collecting, especially since collecting from these structures enables a better center river sample than shore collecting, but use bridges only if these structures are located at fairly equal distances from one another.

4) Organization The class should be broken up into five working teams of 5 to 6 students each. Groups should be numbered and assigned work areas. Each group member should be assigned a specific job to be carried out each day. Jobs may be broken down into 3 types: water collecting, temperature measuring, and data recording. Each member may keep the same job throughout the period or members may alternate jobs each day throughout the study. After the necessary equipment is assigned to each group, members should be familiarized with operation of the equipment before the sampling begins. Upon arriving at the test area each day, the group should prepare their equipment to insure a rapid and uninterrupted collecting procedure. Sample collecting should be done each day on or about the same time by all groups. Care should be taken to synchronize sample collection by the use of a designated collection time each day for all groups.

5) Sample Collection

A) Salinity samples These samples can be taken fairly simply by one or two students using the apparatus described below. This apparatus consists of a plastic one-gallon capacity jar with a 20 ft. length of clothesline rope attached to it (by forming a loop at one end of the rope.) If students work from a bridge, this jar can be lowered from the center of the bridge to the water and the line let out until the jar mouth dips into the water. Let the jar fill slowly with surface water until nearly full and recover. After measuring the temperature, cap the jar and label with the test area number, date, time and collector's name. If working from the shore, the jar with a weight attached may be thrown toward the center of the river by one student while another student holds the rope. The jar should be thrown up current and allowed to fill gradually; when it is nearly full, recover the jar, and cap and label as described. Be sure that at least 300 ml of water are collected since this is the minimum amount needed for each salinity test. More should be taken if duplicate measurements are desired to insure accurate readings or in case of spillage or other errors.

B) Water Temperature Measurements Water temperatures will be taken at the sampling area using the water collected in step 4. After the sample is collected, immerse a centigrade thermometer into the water. Leave the thermometer in the water for about five minutes. Remove the thermometer, read and record the temperature in the data sheet for temperature.

6) Salinity Measurement (to be conducted in the laboratory) Water samples should be brought back to the laboratory and tested for salt content as soon as possible. If testing cannot be done on the same day, water should be stored in an airtight container in a cool place to avoid evaporation. Salinity concentrations of the samples will be measured by measuring the specific gravity, using a hydrometer, and by calculating the salinity from a salinity-specific gravity conversion table. Refer back to Part IV for a step by step procedure for using a hydrometer.

7) Steps 5 and 6 should be repeated each day for 5 consecutive days. Samples and temperatures should be collected at the same area and approximately the same time each day. All salinities should be recorded on salinity data sheets and corresponding temperatures on temperature data sheets for each site. (See sample data sheets.)

8) At the end of data collection all data should be graphed as a function of time and distance. A discussion should also be held in which questions can be answered and ideas can be expanded on the use of the data collected and its relationship. (See suggested discussion questions, p. 33.)

DATA SHEET -- SALINITY

River ______________________ Name ______________________

Time Date →						Comment
Area ↓	Day 1	Day 2	Day 3	Day 4	Day 5	
Area 1 Wind Weather Tidal Direction Salinity						
Area 2 Wind Weather Tidal Direction Salinity						
Area 3 Wind Weather Tidal Direction Salinity						
Area 4 Wind Weather Tidal Direction Salinity						
Area 5 Wind Weather Tidal Direction Salinity						

Note: All Salinity Readings in 0/00 (parts per thousand)
Record direction from which wind is blowing. Record wind speed as high, medium, or light.

DATA SHEET -- TEMPERATURE

River ______________________ Name ______________________

Time Date →						Comment
Area ↓	Day 1	Day 2	Day 3	Day 4	Day 5	
Area 1 Wind Weather Tidal Direction Water Temperature						
Area 2 Wind Weather Tidal Direction Water Temperature						
Area 3 Wind Weather Tidal Direction Water Temperature						
Area 4 Wind Weather Tidal Direction Water Temperature						
Area 5 Wind Weather Tidal Direction Water Temperature						

Note: All Temperature Readings in Centigrade.

Record direction from which wind is blowing. Record wind speed as high, medium, or light.

F. Data Worksheet

GRAPHING

Graph 1: Using the data collected, graph salinity contents at each station over the 5-day period. Compare the graphs for each station. Do they show a tidal pattern?

Graph 2: Using the data collected, graph temperature of each sample over the 5-day period (for each station). Note any great fluctuations. List the possible reasons for these changes.

Graph 3: Using the data collected, graph salinity content for each day at the five sampling stations. Compare the graphs for each day, do they show a tidal pattern? Can you explain why?

Graph 4: Using the data collected, graph the temperature of each sample collected in a one day period at all five stations. Do this for each entire sample day. What type of pattern appears? Can you explain and graph temperature changes from station to station?

G. Discussion Topics

1) Is there a noticeable relationship between salinity content and tidal conditions over the sample period? Why?

2) Is there a relationship between temperature and tidal conditions over the sample period? Why?

3) What type of environmental conditions may affect salinity concentration and water temperature besides tidal movement?

4) Why don't tidal forces usually push salt water completely up the entire length of a tidal river?

5) With such wide salinity concentration and temperature changes occurring so rapidly over such short time periods, what type of animal life would you expect to find in and around a tidal river? What type of plant life?

6) What do you think might happen to the river tide pattern if a long drought occurred? What effects might this have on the larger animal life in the river?

(Possible Responses)

1) Yes, salinity rises as tide is coming in -- salinity drops as tide recedes.

2) Yes, temperature rises as tide recedes. Depth influences temperature. Water movement may also influence temperature.

3) A) Salinity -- rain, evaporation, droughts, wind, etc.

   B) Temperature -- air temperature, rain, river depth, river flow, rate, etc.

4) Because of 1) river basin friction opposing it and 2) fresh water flow.

5) Animals which 1) move with the tidal flow, 2) have a wide salinity and temperature tolerance. Plants which have a high salt tolerance.

6) Salinity concentrations would go up because of fresh water evaporation and reduced fresh water input. Larger animals in the river would move further up the river as salt concentrations rose.

POST TEST

Define the following words:

1) Ebb Tide

2) Flood Tide

3) High Tide

4) Neap Tide

5) Spring Tide

Problems

1) On Tuesday morning starting at 9 A.M., Bill sampled water for salinity from a station on the river, every hour for five hours. He got these results:

9 A.M.	24 $^0/_{00}$	21°C
10 A.M.	20 $^0/_{00}$	22.8°C
11 A.M.	18 $^0/_{00}$	24.6°C
12 N.	15 $^0/_{00}$	26.4°C
1 P.M.	12 $^0/_{00}$	27°C

A) Graph these salinities as they are related to time. Explain why the salinity is dropping.

B) Graph the water temperatures as they are related to time. List <u>two</u> possible reasons for the temperature pattern produced.

2) Using the specific gravity conversion tables and the temperature correction table, what would be the salinity content of the following samples?

A) SP. GR. = 1.0050 at 18°C

B) SP. GR. = 1.0150 at 20°C

C) SP. GR. = 1.0180 at 16°C

D) SP. GR. = 1.0010 at 15°C

<u>True or False</u>

1) _______ As flood tide occurs, salt water is moving further up the river.

2) _______ Tides affect only salt water bodies.

3) _______ Tidal periods from high tide to high tide last approximately 12 hours and 25 minutes.

4) _______ The sampling study was done at the same hour each day because high tide occurs at the same time each day.

5) _______ Tides are caused mainly by the gravitational pull of the earth on the moon.

POST TEST

(Answer Sheet)

Define the following words:

1) Ebb Tide — As water level is dropping from high to low tide.

2) Flood Tide — As water level is rising from low to high tide.

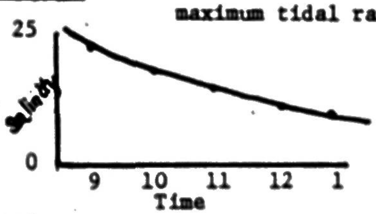
3) High Tide — Point at which water level has reached its highest level.

4) Neap Tide — Occurs twice a month -- sun and moon forces oppose each other -- minimum tidal range caused.

5) Spring Tide — Occurs between neat tides -- sun and moon forces join -- a maximum tidal range occurs.

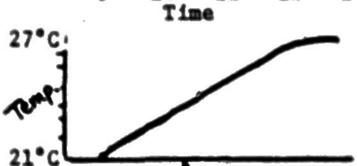
Problems

1) A)



Salinity is dropping because tide is ebbing.

B)



Reasons: 1) Temperature rises as water level drops because of ebbing tide.

2) Sun is rising, heating water as day passes.

2) A) 8.3

B) 21.9

C) 24.8

D) 2.5

True or False

1) True

2) False

3) True

4) False

5) False

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